

CHAPTER 300 GEOMETRIC CROSS SECTION

Topic 301 - Traveled Way Standards

Index 301.1 - Traveled Way Width

The traveled way width is determined by the number of lanes demanded by the design hourly volume. **The basic lane width for new construction on two lane and multilane highways, ramps, collector roads and other appurtenant roadways shall be 3.6 m.** For roads under other jurisdictions, see Topic 308.

301.2 Cross Slopes

- (a) **The standard cross slope to be used for new construction on the traveled way for all types of surfaces shall be 2%.**
- (b) **For resurfacing or widening when necessary to match existing cross slopes, the minimum shall be 1.5% and the maximum shall be 3 percent.** However, the cross slope on 2-lane and multilane AC highways should be increased to 2% if the cost is reasonable.
- (c) **On unpaved roadway surfaces, including gravel and penetration treated earth, the cross slope shall be 2.5% to 5.0%.**

On undivided highways with two or more lanes in a normal tangent section, the high point of the crown should be centered on the pavement and the pavement sloped toward the edges on a uniform grade.

For rehabilitation and widening projects, the maximum algebraic difference in cross slope between adjacent lanes of opposing traffic for either 2-lane or undivided multilane highways should be 6%. **For new construction, the maximum shall be 4%.**

On divided highway roadbeds, the high point of crown may be centered at, or left of, the center of the traveled way, and preferably over a lane line (tent sections). This strategy may be employed when adding lanes on the inside of divided highways, or when widening an existing "crowned" 2-lane highway to a 4-lane divided highway by utilizing the existing 2-lane pavement as one of the divided highway roadbeds.

The maximum algebraic difference in cross slope between same direction traffic lanes of divided highway roadbeds should be 4%.

The maximum difference in cross slope between the traveled way and the shoulder should not exceed 8%. This applies to new construction as well as pavement overlay projects.

Topic 302 - Shoulder Standards

302.1 Width

The shoulder widths given in Table 302.1 shall be the minimum continuous usable width of paved shoulder. For new construction, and major reconstruction projects on conventional highways, adequate width should be provided to permit shared use by motorists and bicyclists.

See Index 308.1 for shoulder width requirements on city streets or county roads. See shoulder definition, Index 62.1(7).

302.2 Cross Slopes

In a normal tangent section, shoulders to the right of traffic shall slope on a 5% grade away from the traveled way. For divided cross sections, the shoulders to the left of traffic shall slope as follows:

- (1) ***Paved Median.* In the plane of the traveled way.**
- (2) ***Depressed Median and Separate Roadways.* Two percent away from traveled way.**

Table 302.1
Standards for Paved
Shoulder Width

	Paved Shoulder Width (m)	
	Left	Right
Freeways & Expressways		
2 lanes (1)	--	2.4 (7)
4 lanes (1)	1.5	3.0
6 or more lanes (1)	3.0	3.0
Auxiliary lanes	--	3.0
Freeway-to-freeway connections		
Single and two-lane connections	1.5	3.0 (2)
Three-lane connections	3.0	3.0
Single-lane ramps	1.2 (3)	2.4
Multilane ramps	1.2 (3)	2.4 (4)
Multilane undivided	--	3.0
Collector-Distributor	1.5	3.0
Conventional Highways		
Multilane divided		
4-lanes	1.5	2.4
6-lanes or more	2.4	2.4
Urban areas with speeds less than 75 km/h and curbed medians	0.6 (5)	2.4
Multilane undivided	--	2.4
2-lane		
RRR	See Table 307.3	
New construction	See Table 307.2	
Slow-moving vehicle lane	--	1.2 (6)
Local Facilities		
Frontage roads	See Index 310.1	
Local facilities crossing State facilities	See Index 308.1	

NOTES:

- (1) Total number of lanes in both directions including separate roadways (see Index 305.6). If a lane is added to one side of a 4-lane facility (such as a truck climbing lane) then that side shall have 3.0 m left and right shoulders. See Index 62.1.
- (2) May be reduced to 1.5 m for a single lane freeway-to-freeway connector widened to 2-lanes to provide passing opportunities.
- (3) May be reduced to 0.6 m. 1.2 m preferred in urban areas and/or when ramp is metered. See "Ramp Meter Design Guidelines".
- (4) In restrictive situations, may be reduced to 0.6 m or 1.2 m (preferred in urban areas) in the 2-lane section of a non-metered ramp which transitions from a single lane. May be reduced to 0.6 m in ramp sections having 3 or more lanes. See Index 504.3 and the "Ramp Meter Design Guidelines".
- (5) See Index 209.3
- (6) On right side of climbing or passing lane section only. See Index 1003.2 if bike lanes are present.
- (7) 3.0 m shoulders preferred.

- (3) *Future Widening.* **If there are plans for future use of the shoulder as a traffic lane and the shoulder is built to traveled way standards, the shoulder slope shall match the traveled way.** Special consideration must be given to drainage when the shoulder cross slope is flatter than 5%.

Shoulder slopes for super elevated curves are discussed under Index 202.2.

See Index 307.2 for shoulder slopes on 2-lane roads with 0.6 m and 1.2 m shoulders.

Topic 303 - Dike and Side Gutters

303.1 Asphalt Concrete Dikes

See Index 835.3 for a discussion on the use of asphalt concrete dikes.

303.2 Side Gutters

For information on locations where side gutters are used, see Index 834.3.

Topic 304 - Side Slopes

304.1 Side Slope Standards

In the design of side slopes, consideration should be given to the specific recommendations of the Project Materials Report (See Topic 113), functional effectiveness, ease and cost of long-term maintenance, pleasing appearance, traffic safety, economics of eliminating curbs, dikes, guardrail, and drainage collection systems, and overall economy. Cut and fill slopes should normally be no steeper than 1:2 for freeways and expressways and 1:1.5 for other highways except as follows:

- (a) On freeways with separate roadways, 1:1.5 cut slopes between roadways are permissible.
- (b) Steeper cut or fill slopes should be discussed in the Project Materials Report and recommendation given as to the stability of the material and the monetary savings or environmental benefits that will result.

Slopes flatter than the steepest allowable should be used, if economically feasible. In general, flatter slopes are safer, more resistant to erosion, and more pleasing to the eye. Slopes 1:3 or flatter generally eliminate the need for guardrail. In some cases, the cost of stabilizing, planting, and maintaining steep slopes may exceed the cost of additional grading and right of way to provide a flatter slope.

In light grading where normal slopes catch in a distance less than 5.5 m from the edge of the shoulder, a uniform catch point, at least 5.5 m from the edge of the shoulder, should be used.

Transition slopes should be provided between adjoining cuts and fills. Such slopes should intersect the ground at the uniform catch point line.

In areas where heavy snowfall can be expected, consideration should be given to snow removal problems and snow storage in slope design. It is considered advisable to use flatter slopes in cuts on the southerly side of the roadway where this will provide additional exposure of the pavement to the sun.

304.2 Clearance From Slope to Right of Way Line

The minimum clearance from the right of way line to catch point of a cut or fill slope should be 3 m for all types of cross sections. When feasible, at least 5 m should be provided.

Following are minimum clearances recommended for cuts higher than 10 m:

- (a) 6 m for cuts from 10 m to 15 m high.
- (b) 7.5 m for cuts from 15 m to 25 m high.
- (c) One-third the cut height for cuts above 25 m, but not to exceed a width of 15 m.

The foregoing clearance standards should apply to all types of cross sections.

304.3 Slope Benches and Cut Widening

The necessity for benches, their width, and vertical spacing should be established only after an adequate materials investigation. Since greater traffic benefits are realized from widening a cut than from benching the slope, benches above grade should be used sparingly. Benches above grade should be used only where there is

a purpose such as installation of horizontal drains, control of surface erosion, or intercepting falling rocks. Design of the bench should be compatible with the geotechnical features of the site.

Benches should be at least 6 m wide and sloped to form a valley at least 0.3 m deep with the low point a minimum of 1.5 m from the toe of the upper slope. Access for maintenance equipment should be provided to the lowest bench, and if feasible to all higher benches.

In cuts over 45 m in height, with slopes steeper than 1:1.5, a bench above grade may be desirable to intercept rolling rocks. The Office of Structural Foundations should be consulted for assistance in recommending special designs to contain falling and/or rolling rocks.

Cut widening may be necessary:

- (a) To provide for drainage along the toe of the slope.
- (b) To intercept and store loose material resulting from slides, rock fall, and erosion.
- (c) For snow storage in special cases.

Where the widened area is greater than that required for the normal gutter or ditch, it should be flush with the edge of the shoulder and sloped upward or downward on a gentle slope, preferably 1:20 in areas of no snow; and downward on a 1:10 slope in snow areas.

304.4 Contour Grading and Slope Rounding

Pleasing aesthetic roadside effects can be developed with easy flowing contours. Contour grading is an important factor in roadside preparation, erosion control, and maintenance of planting. Contour grading plans should be prepared to facilitate anticipated roadside treatment. These plans should show flattening of slopes where right of way permits.

The tops and ends of all cut slopes should be rounded where the material is other than solid rock. A layer of earth overlying a rock cut also should be rounded.

304.5 Stepped Slopes

Stepped cut slopes should be used to encourage material revegetation from the adjacent plants.

Stepped slopes are a series of small benches 0.3 m to 0.6 m wide. Generally, stepped slopes can be used in rippable material on slopes 1:2 or steeper. Steps may be specified for slopes as flat as 1:3. Steps are provided to capture loose material, seed, and moisture.

For appearance, steps on small cuts viewed from the roadway should be cut parallel to the road grade. Runoff is minimized on steps cut parallel to roads with grades up to 10%, as long as the natural ravel from construction is left on the steps. Steps less than one-half full should not be cleaned.

High cuts viewed from surrounding areas should be analyzed before a decision is made to form steps parallel to the roadway or horizontal. In some cases, horizontal steps may be more desirable. Special study is also necessary when a sag occurs in the vertical alignment within the cut. In all cases at the ends of cuts, the steps should wrap around the rounded transition.

The detail or contract special provisions should allow about a 20% variation, expressed in terms of millimeters. Some irregularity will improve the appearance of the slope by making it appear more natural.

In designing step width, the material's weathering characteristics should be considered. Widths over approximately 0.6 m should be avoided because of prominence and excessive time to achieve a weathered and natural appearance. Contact the Office of Structural Foundations if questions arise about the width of steps.

Topic 305 - Median Standards

305.1 Width

Median width is the distance between inside edges of traveled way. This width is dependent upon the type of facility, costs, topography, and right of way. Consideration may be given to the possible need to construct a wider median than prescribed in Cases (1), (2), and (3), below, in order to provide for future expansion to accommodate:

- (a) Other modes of transportation.
- (b) Traffic needs more than 20 years after completion of construction.

Any recommendation to provide additional median width should be identified and documented as early as possible and must be justified in a Project Study Report and/or Project Report. Attention should be given to such items as initial costs, future costs for outside widening, the likelihood of future needs for added mixed flow or High Occupancy Vehicle (HOV) lanes, traffic interruption, future mass transit needs and right of way considerations. (For instance, increasing median width may add little to the cost of a project where an entire city block must be acquired in any event.)

If additional width is justified, the minimum median widths provided below should be increased accordingly.

Minimum median widths for the design year (as described below) should be used in order to accommodate the ultimate highway facility (type and number of lanes):

(1) Freeways and Expressways.

- (a) Urban Areas. Where HOV lanes or transit facilities are planned, the minimum median width should be 18.6 m. Where there is little or no likelihood of HOV lanes or transit facilities planned for the future, the minimum median width should be 13.8 m. However, where physical and economic limitations are such that a 13.8 m median cannot be provided at reasonable cost, the minimum median width for freeways and expressways in urban areas should be 10.8 m.
- (b) Suburban Areas. The minimum median width for freeways and expressways in suburban areas should be 18.6 m. Suburban areas can be described as those where there is a strong possibility that the surrounding properties will be converted into urban type development during or beyond the design year. The additional median width will provide for construction of mixed flow lanes, HOV lanes, or transit facilities.
- (c) Rural Areas. The minimum median width for freeways and expressways in rural areas should be 18.6 m.

(2) *Conventional Highways.* Appropriate median widths for non-controlled access highways vary widely with the type of facility being designed. In city street conditions the minimum median width for multilane conventional highways should be 3.6 m. This median width will provide room for left turn pockets at intersections, and/or the ultimate construction of two way left turn lanes. Where two way left turn lanes are proposed, median widths in excess of 3.6 m are occasionally provided to conform with local agency standards (see Index 405.2); however, the median width should not exceed 4.2 m. **In rural areas the minimum median width for multilane conventional highways shall be 3.6 m.** This provides the minimum space necessary to accommodate a median barrier and 1.5 m shoulders. Whenever possible, and where it is appropriate, this minimum width should be increased to 9.0 m or greater.

(3) *Facilities under Restrictive Conditions.* Where certain restrictive conditions, including steep mountainous terrain, extreme right of way costs, and/or significant environmental factors are encountered, the basic median widths described above may not be attainable. Where such conditions exist, a narrower median, down to the limits given below, may be allowed with adequate justification. (See Index 307.5.)

- (a) Freeways and Expressways. **In areas where restrictive conditions prevail the minimum median width shall be 6.6 m.**
- (b) Conventional Highways. Median widths should be consistent with requirements for two way left turn lanes or the need to construct median barriers (as discussed in Index 305.1(2)), but may be reduced or eliminated entirely in extreme situations.

The above stated minimum median widths should be increased at spot locations to accommodate the construction of bridge piers or other planned highway features while maintaining standard cross section elements such as inside shoulder width and horizontal clearance. If a bridge pier is to be located in a

tangent section, the additional width should be developed between adjacent horizontal curves; if it is to be located in a curve, then the additional width should be developed within the limits of the curve. Provisions should be made for piers 2 m wide or wider. Median widths in areas of multilevel interchanges or other major structures should be coordinated with the DOS.

Consideration should also be given to increasing the median width at unsignalized intersections on expressways and divided highways in order to provide a refuge area for large trucks attempting to cross the State route.

In any case, the median width should be the maximum attainable at reasonable cost based on an individual analysis of each project.

See Index 608.5 for median structural section requirements.

305.2 Median Cross Slopes

Unsurfaced medians up to 20 m wide should be sloped downward from the adjoining shoulders to form a shallow valley in the center. Cross slopes should be 1:10 or flatter; 1:20 being preferred. Slopes as steep as 1:6 are acceptable in exceptional cases when necessary for drainage, stage construction, etc. Cross slopes in medians 20 m and wider should be treated as separate roadways (Index 305.6).

Paved medians, including those bordered by curbs, should be crowned at the center, sloping towards the sides at the slope of the adjacent pavement.

305.3 Median Barriers

See Chapter 7 of the Traffic Manual.

305.4 Median Curbs

Curbs should not be used in State highway medians except as provided under Topic 209 and in Index 405.5(1).

305.5 Paved Medians

(1) *Freeways.*

- (a) 6 or More Lanes--Medians 9.0 m wide or less should be paved.
- (b) 4 Lanes--Medians 6.6 m or less in width should be paved. Medians between 6.6 m and 9.0 m wide, should be paved

only if a barrier is installed. With a barrier, medians wider than 9.0 m should not normally be paved.

Where medians are paved, each half generally should be paved in the same plane as the adjacent traveled way.

- (2) *Nonfreeways.* Unplanted curbed medians generally are to be surfaced with 50 mm of asphalt concrete.

For additional information on median cross slopes see Index 305.2.

305.6 Separate Roadways

- (1) *General Policy.* Separate grade lines are not considered appropriate for medians less than 20 m wide (see Index 204.8).
- (2) *Median Design.* The cross sections shown in Figure 305.6 with a 6.9 m graded area left of traffic are examples of median treatment to provide maneuvering room for out-of-control vehicles. This optional treatment may be used where extra recovery area is desired (see Index 307.6).

See Index 302.1 for shoulder widths and Index 302.2 for shoulder cross slopes.

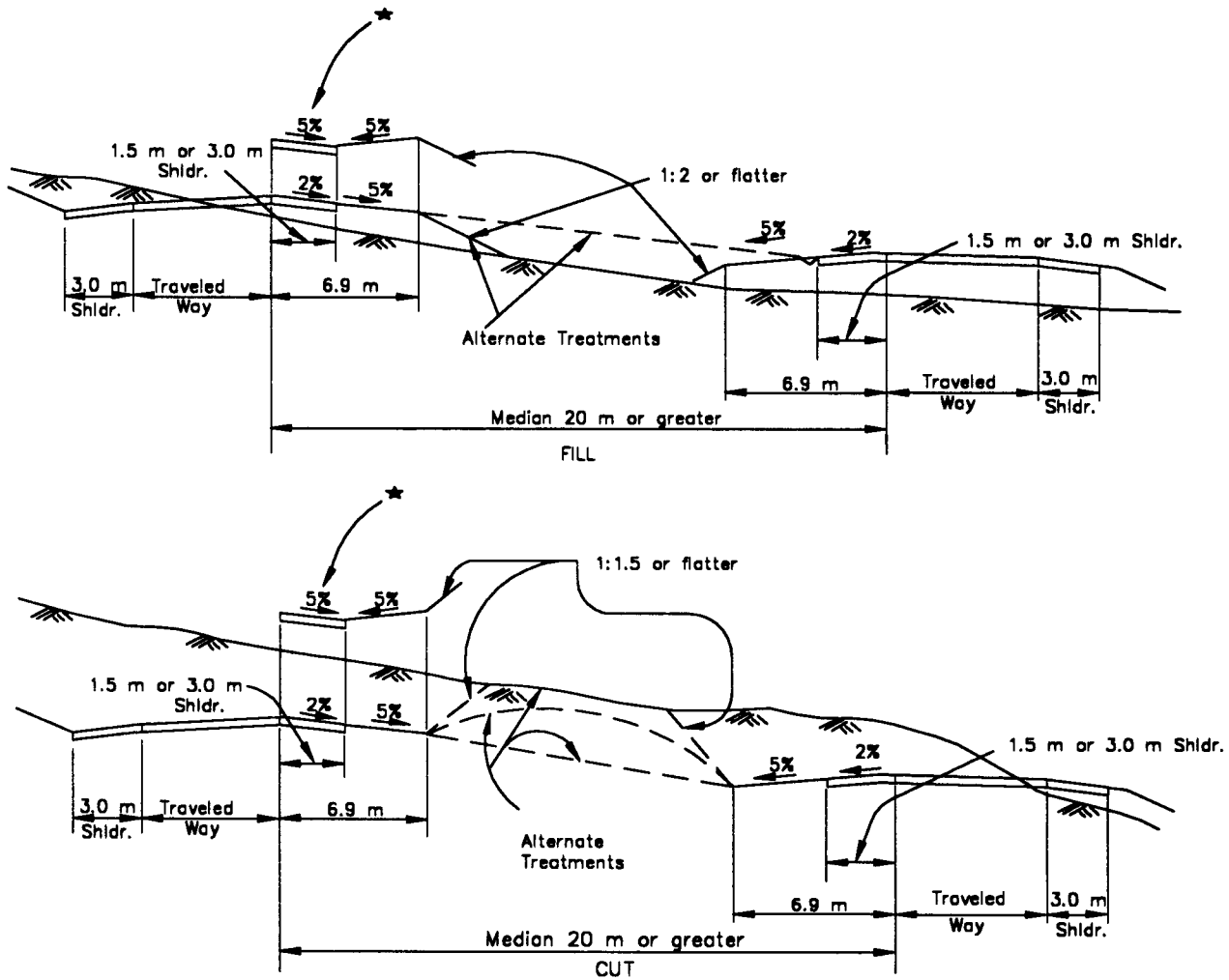
Topic 306 - Right of Way

306.1 General Standards

The right of way widths for State highways, including frontage roads to be relinquished, should provide for all cross section elements including median, traffic lanes, outside shoulders, recovery areas, slopes, outer separations, ramps, walls, and other essential highway appurtenances. For minimum clearance from the right of way line to the catch point of a cut or fill slope, see Index 304.2. Fixed minimum widths of right of way, except for 2-lane highways, are not specified because dimensions of cross-sectional elements may require narrow widths, and right of way need not be of constant width. The minimum right of way width on new construction for 2-lane highways should be 40 m.

Figure 305.6

Optional Median Design for Freeways with Separate Roadways



NOTES:

Left Paved Shoulder Width
 3.0 m for 6 and 8 lanes
 1.5 m for 4 lanes

Side Slopes
 See Index 304.1

★ Superelevated section

306.2 Right of Way Through the Public Domain

Right of way widths to be obtained or reserved for highway purposes through lands of the United States Government or the State of California are determined by laws and regulations of the agencies concerned.

Topic 307 - Cross Sections for State Highways

307.1 Warrants

The selection of a cross section is based upon traffic, terrain, safety, and other considerations. For 2-lane roads the roadbed width is influenced by the factors discussed under Index 307.2. The roadbed width for multilane facilities should be adequate to provide capacity for the design hourly volume based upon capacity considerations discussed under Index 102.1.

307.2 Two-lane Cross Sections for New Construction

These standards are to be used for highways on new alignment as well as on existing highways where the width, alignment, grade, or other geometric features are being upgraded.

A 2-lane, 2-way roadbed consists of a 7.2 m wide traveled way plus paved shoulders. **In order to provide structural support, the minimum paved width of each shoulder shall be 0.6 m.** Development and maintenance of 1.2 m paved shoulders should be considered when bicyclists are present. See Topic 1003 for information on bicycle design criteria and Figure 307.2 for typical 2-lane cross sections.

Shoulder widths based on design year traffic volumes shall conform to the standards given in Table 307.2.

On 2-lane roads with 1.2 m shoulders, the shoulder slope may be increased to 7% for additional drainage capacity where a dike is used. With 0.6 m shoulders the shoulder slope should be 2% without a dike, but may be increased to a maximum of 9% for additional drainage capacity with a dike.

Shoulder widths of 1.2 m or less should be constructed in accordance with the "All Paved Cross Section" of Figure 307.2 in order to provide essentially the same structural section throughout the full roadbed width.

Minimum width of 2-lane State highways functionally classified as collectors may be as given in Table V1-4 of "A Policy on Geometric Design of Highways and Streets", AASHTO, 1994. Up-to-date information on the functional classification of State highways may be obtained from Headquarters Office of Highway System Engineering.

Table 307.2

Shoulder Widths for Two-lane Roadbed New Construction Projects

Two-way ADT (Design Year)	Shoulder Width ⁽¹⁾ (m)
Less than 400	0.6 or 1.2 ⁽²⁾
Over 400	2.4

(1) See Index 1003.2 for shoulder requirements when bike lanes are present.

(2) Bridge width is to be 9.6 m minimum (see Index 208.1).

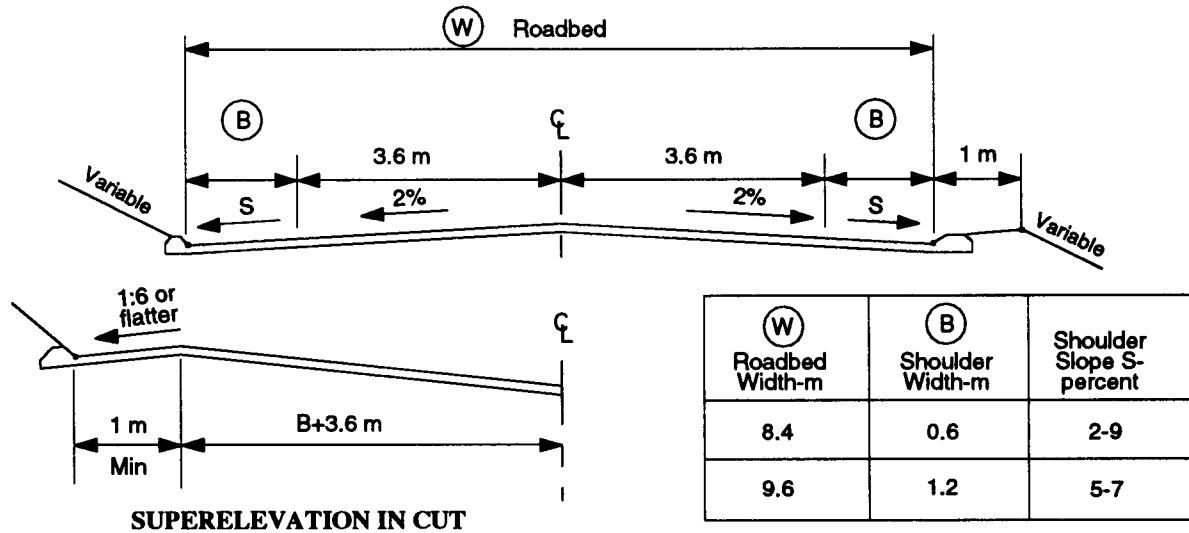
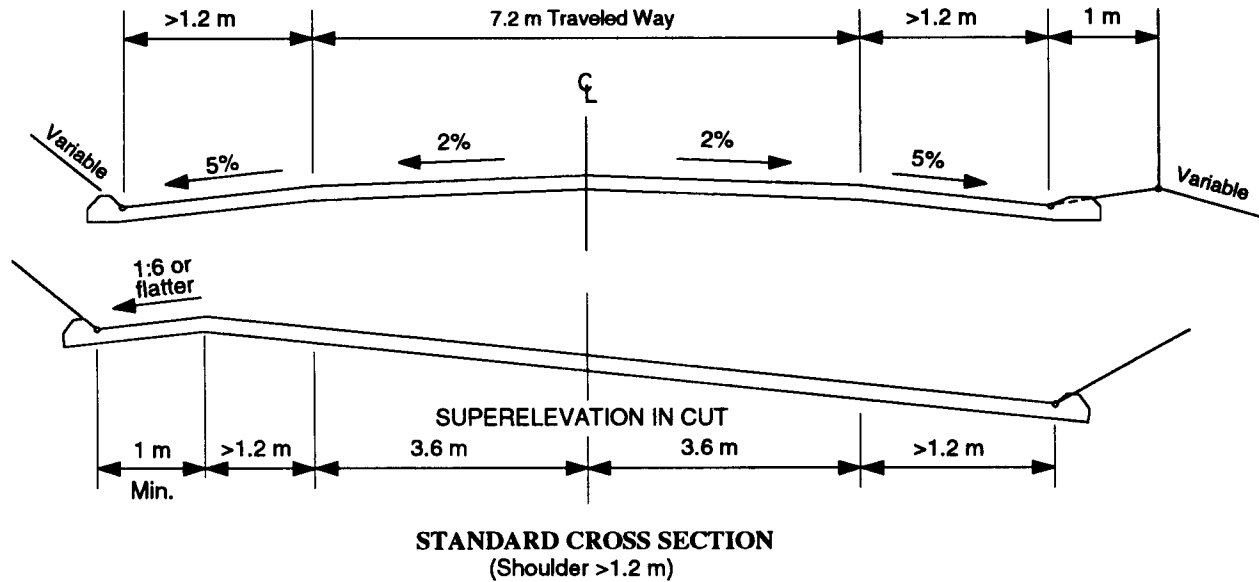
307.3 Two-lane Cross Sections for RRR Projects

(1) *General.* These standards have been excerpted from Design Information Bulletin Number 75 (DIB No. 75), "Geometric Design Criteria for Resurfacing, Restoration, and Rehabilitation (RRR) Projects", dated April 15, 1991, and the June 26, 1991 memorandum providing clarification of DIB No. 75.

The above referenced documents also contain additional geometric design criteria and policies pertinent to the development of RRR projects.

See Index 1002.1 for more information.

Figure 307.2
Geometric Cross Sections for
Two-lane Highways
(New Construction)

**NOTES**

SIDE SLOPES	See Index 304.1
DIKES	See Index 835.3
RIGHT OF WAY	See Index 306.1
SIDE GUTTERS	See Index 834.3(3)

(2) *Geometric Design Criteria.*

(a) Roadbed Width -- The "Roadbed Minimum" column from Table 307.3 shall be the RRR standard applied to roadbeds. Roadbed is defined as traveled way plus paved shoulders. Roadbeds less than the "Roadbed Minimum" shall be widened to the "Roadbed Desirable Minimum". Roadbeds at or above "Minimum" may be rehabilitated at their existing widths (including minor widening for lateral support or uniformity of pavement width) unless the safety analysis indicates a deficiency that requires widening, in which case the roadbed shall be widened to the "Desirable Minimum".

(b) Bridge Width--The "In-Place Bridge Minimum" from Table 307.3 shall be the standard width for bridges to remain in place with the condition that the clear width shall equal or exceed the approach roadbed width. Bridge width is defined as the clear width between curbs or rails, whichever is less. Bridges which are at or exceed the "In-Place Bridge Minimum" may be left in place and rehabilitated as appropriate regarding joint reconstruction, deck seals, etc. **Bridges that are within the limits of an RRR project and are less than the "In-Place Bridge Minimum" shall be widened according to the "Bridge Widened" column of Table 307.3.**

The upgrading of existing bridge rail, approach guardrail, and guardrail connections shall be included in the RRR project, regardless of the widening requirements discussed above.

The deferral of bridge widening or rail upgrading work may be considered when the completion of the Structure PS&E for such work will result in a

Table 307.3

**RRR Width⁽¹⁾ Standards for
Bridges
and Roadbeds**

Current ADT	Bridge Widened (m)	In-Place Bridge Min. & Roadbed Desirable Min. (m)	Roadbed ⁽²⁾ Min. (m)
0-250	9.6	7.2	7.2
251-400	9.6	7.8	7.2
401-1000	9.6	8.4	7.2
1001-3000	12.0	9.6	8.4
3001-6000	12.0	10.8 & 12.0 ⁽³⁾	8.4
Over 6000	12.0	12.0	9.6

(1) Bridge width is defined as the clear width between curbs or rails, whichever is lesser. Roadbed is defined as the traveled way plus paved shoulders. Width criteria for new and reconstructed bridges are given under Index 208.1.

(2) The truck usage on the highway should be considered when determining roadbed widths.

(3) The "In-Place Bridge Min." is 10.8 m, and the "Roadbed Desirable Min." is 12.0 m. Design exception approval is required whenever the approach roadbed width is greater than the bridge width.

significant delay to the completion of the RRR project. This deferral does not preclude the requirement for documentation as discussed in Index 82.2.

(c) Exceptions--Unless there are extreme conditions or issues such as high costs, environmental impacts, and/or non-compatibility with adjacent segments of roadway that are less than the "Desirable Minimum", exceptions to the above design criteria should not be requested. The need to acquire right of way is not in itself a reason for exception.

Exceptions to these RRR design criteria must be formally approved in accordance with the requirements of Index 82.2, "Approvals for Nonstandard Design." Formal design exception approval is also required to allow existing nonstandard project features (i.e. widths and rails) to remain until the completion of deferred work.

307.4 Multilane Divided Cross Sections

The general geometric features of multilane divided cross sections are shown in Figure 307.4.

Divided highways may be designed as two separate one-way roads where appropriate to fit the terrain. Economy, pleasing appearance, and safety are factors to be considered in this determination. The alignment of each roadway may be independent of the other (see Indexes 204.8 and 305.6). Optional median designs may be as shown on Figure 305.6.

307.5 Multilane All Paved Cross Sections with Special Median Widths

A multilane cross section with a narrow median is illustrated in Figure 307.5. This section is appropriate in special circumstances where a wider median would not be justified. It should not be considered as an alternative to sections with the median widths set forth under Index 305.1. It may be used under the following conditions:

- (a) Widening of existing facilities.
- (b) Locations where large excavation quantities would result if a multilane roadway cross section with a basic median width were used. Examples are steep mountainous terrain and unstable mountainous areas.
- (c) As an alternate cross section on 2-lane roads having frequent sight distance restrictions.

The median width should be selected in accordance with the criteria set forth in Index 305.1(3).

In general, the outside shoulder should be 2.4 m wide (3.0 m on freeways and expressways) as mandated in Table 302.1. Where large

excavation quantities or other factors generate unreasonable costs, 1.2 m shoulders may be considered. However, a design exception is required except where 4-lane passing sections are constructed on 2-lane highways. Where the roadbed width does not contain 2.4 m shoulders, emergency parking areas clear of the traveled way should be provided by using daylighted cuts and other widened areas which develop during construction.

307.6 Multilane Cross Sections for RRR Projects

RRR projects on freeways, expressways, and multilane conventional highways are generally required to meet new construction standards.

For additional information, see Design Information Bulletin Number 75, "Geometric Design Criteria for Resurfacing, Restoration, and Rehabilitation (RRR) Projects."

Topic 308 - Cross Sections for Roads Under Other Jurisdictions

308.1 City Streets and County Roads

The width of local roads and streets that are to be reconstructed as part of a freeway project should conform to AASHTO standards if the local road or street is a Federal-aid route. Otherwise the cross section should match the width of the city street or county road adjoining the reconstructed portion, or the cross section should satisfy the local agency's minimum standard for new construction.

Where a local facility within the State right of way crosses over or under a freeway or expressway but has no connection to the State facility, the minimum design standards for the cross section of the local facility within the State's right of way shall be those found in AASHTO. If the local agency has standards that exceed AASHTO standards, then the local agency standards should apply.

AASHTO standards for local roads and streets are given in "A Policy on Geometric Design of Highways and Streets", AASHTO, 1994.

Figure 307.4
Geometric Cross Sections for
Freeways and Expressways

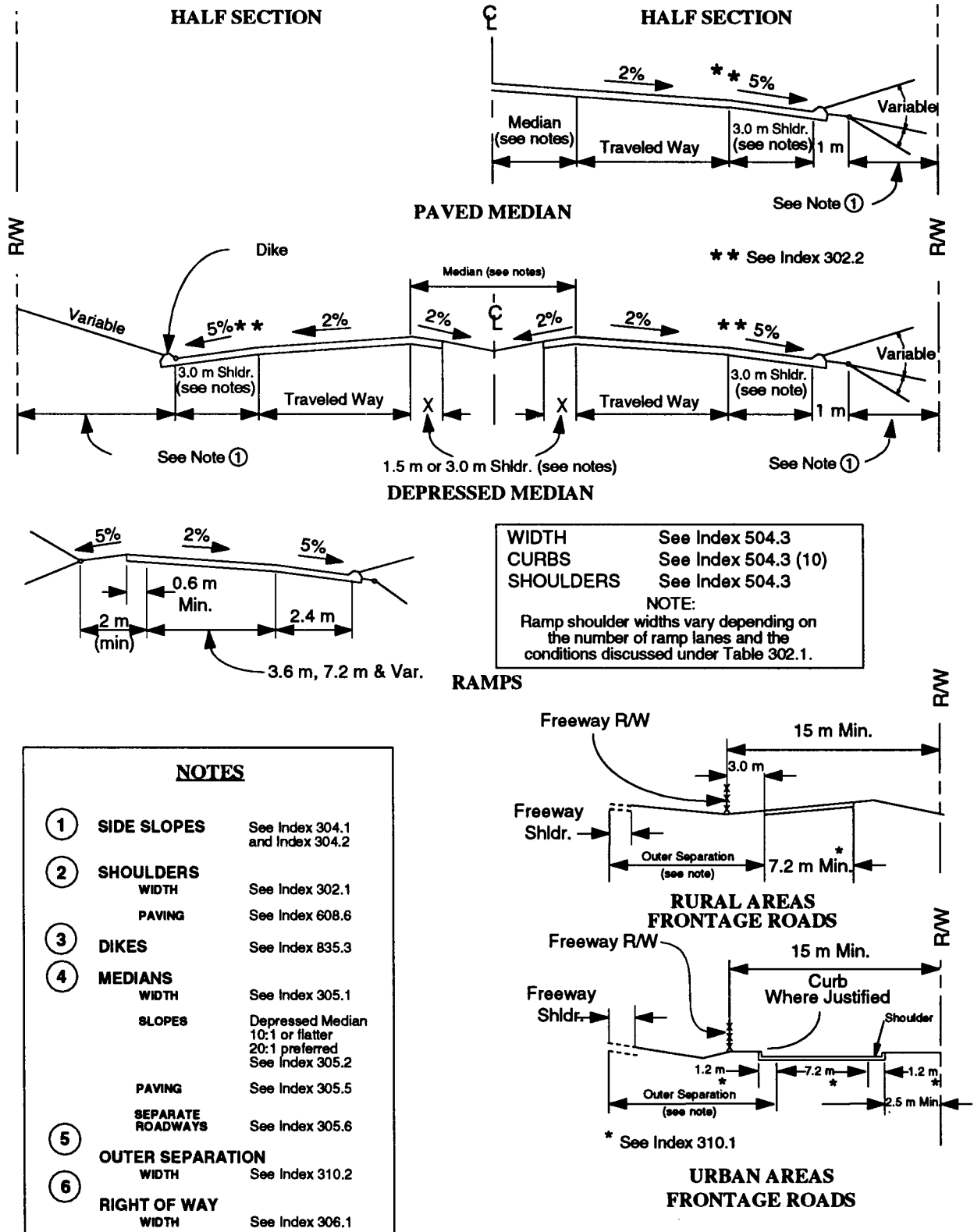
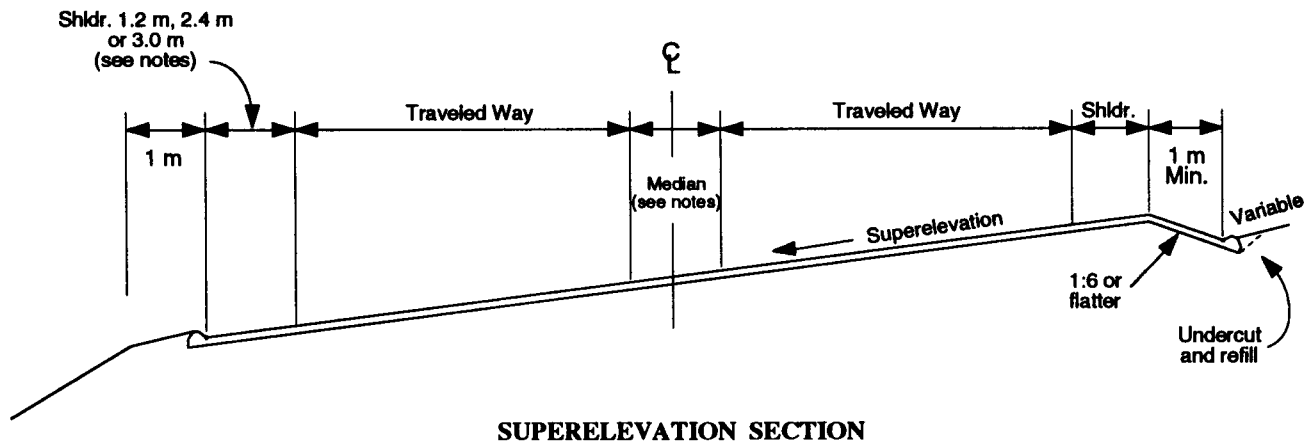
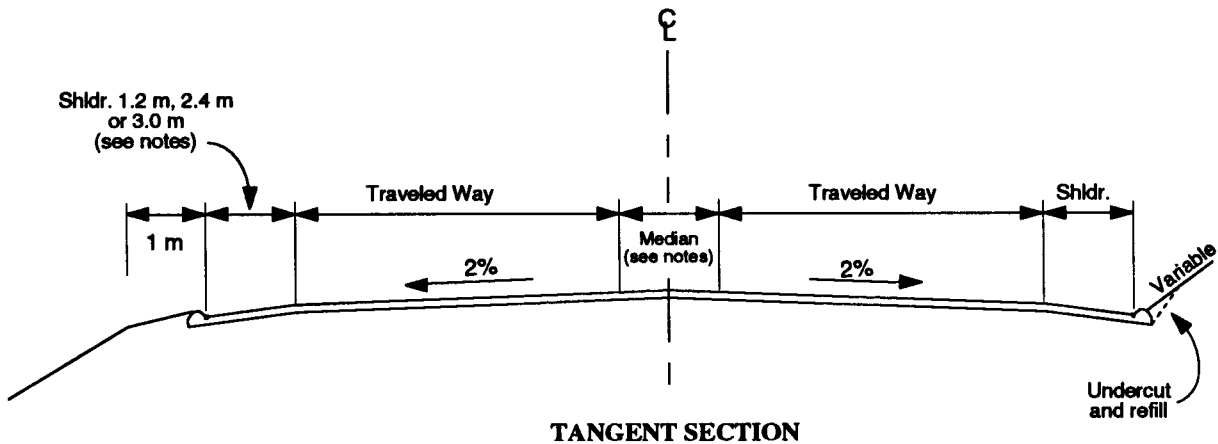


Figure 307.5

Geometric Cross Sections for All Paved Multilane Highways



NOTES

SIDE SLOPES	See Index 304.1
SHOULDERS	See Index 307.5
MEDIANS	See Index 305.1 (3)
DIKES	See Index 835.3
RIGHT OF WAY	See Index 306.1
SIDE GUTTERS	See Index 834.3 (3)

It is important to note that "A Policy on Geometric Design of Highways and Streets", AASHTO, 1994, standards are based on functional classification and not on a Federal-aid System.

Chapters V, VI and VII of the "A Policy on Geometric Design of Highways and Streets", AASHTO, 1994, list standards for the following six functional classes:

- Local rural roads
- Local urban streets
- Rural collectors
- Urban collectors
- Rural arterials
- Urban arterials

"A Policy on Geometric Design of Highways and Streets", AASHTO, 1994, gives minimum lane and shoulder widths. When selecting a cross section, the effects on capacity of commercial vehicles and grades should be considered as discussed under Topic 102 and in the "Highway Capacity Manual", 1994.

The minimum width of 2-lane overcrossing structures shall not be less than 8.4 m curb to curb. Also see Index 208.1(2) and Index 307.3.

If the local agency has definite plans to widen the local street either concurrently or within 5 years following freeway construction, the reconstruction to be accomplished by the State should generally conform to the widening planned by the local agency. Stage construction should be considered where the planned widening will occur beyond the 5-year period following freeway construction or where the local agency has a master plan indicating an ultimate width greater than the existing facility. Where an undercrossing is involved, the initial structure construction should provide for ultimate requirements.

Where a local facility crosses over or under a freeway or expressway and connects to the State facility (such as ramp terminal intersections), the minimum design standards for the cross section of the local facility shall be at least equal to those for a conventional highway with the exception that the

outside shoulder width shall match the approach roadway, but not less than 1.2 m (shoulder width should not be less than 1.5 m where curbs with 600 mm gutter pans are proposed and bicycle use is expected). The minimum width for two-lane overcrossings at interchanges shall be 12.0 m curb-to-curb.

Topic 309 - Clearances

309.1 Horizontal Clearances

(1) *General.* The horizontal clearance to all fixed roadside objects including bridge piers, abutments, retaining walls, and noise barriers should be based on engineering judgment with the objective of maximizing the distance between fixed objects and the edge of traveled way. Engineering judgment should be exercised in order to balance the achievement of horizontal clearance objectives with the prudent expenditure of available funds.

Certain yielding objects, such as sand filled barrels, metal beam guard rail, breakaway wood posts, etc. may encroach within the clear recovery zone (see Index 309.1(2)). While these objects are designed to reduce the severity of accidents, efforts should be made to maximize the distance between any object and the edge of traveled way.

Clearances are measured from the edge of the traveled way to the nearest point on the obstruction (usually the bottom). **Horizontal clearances greater than those cited below under subsection (3) - "Minimum Clearances" shall be provided where necessary to meet horizontal stopping sight distance requirements to median barriers, bridge rails, bridge columns, retaining walls, cut slopes, and noise barriers.** See discussion on "... technical reductions in design speed ..." under Topic 101.

(2) *Clear Recovery Zone.* A clear recovery zone is an unobstructed, relatively flat or gently sloping area beyond the edge of the traveled way which affords the drivers of errant vehicles the opportunity to regain control.

The following clear recovery zone widths are the minimum desirable for the type of facility indicated. Consideration should be given to increasing these widths based on traffic volumes, operating speeds, terrain, and costs associated with a particular highway facility:

- Freeways and Expressways - 9 m
- Conventional Highways (no curbs) - 6 m
- Conventional Highways (with curbs)* - 0.5 m

* This clear zone is measured from the face of curb to the obstruction.

Fixed objects which are closer to the edge of traveled way than the distances listed above should be eliminated, moved, redesigned to be made yielding, or shielded in accordance with the following guidelines:

- (a) Fixed objects should be eliminated or moved outside the clear recovery zone to a location where they are unlikely to be hit.
- (b) If sign posts 150 mm or more in any dimension or light standards cannot be eliminated or moved outside the clear recovery zone, they should be made yielding with a breakaway feature.
- (c) If a fixed object cannot be eliminated, moved outside the clear recovery zone, or modified to be made yielding, it should be shielded by guardrail or a crash cushion.

Where compliance with the above stated clear recovery zone guidelines is impractical, the minimum horizontal clearance cited below shall apply to the unshielded fixed object.

- (3) *Minimum Clearances.* **The following minimum horizontal clearances shall apply to fixed objects that are closer to the edge of traveled way than the clear recovery zone distances listed above:**

- (a) **The minimum horizontal clearance to fixed objects such as bridge rails, safety-shaped concrete barriers, abutments, retaining walls or noise barriers**

on all freeway and expressway facilities, including auxiliary lanes, ramps, and collector roads shall be equal to the standard shoulder width of the highway facility as stated in Table 302.1. A minimum clearance of 1.2 m shall be provided where the standard shoulder width is less than 1.2 m. Approach rail connections to bridge rail may require special treatment to maintain the standard shoulder width.

- (b) **On two-lane highways, frontage roads, city streets and county roads (all without curbs), the minimum horizontal clearance shall be the standard shoulder width as listed in Tables 302.1 and 307.2, except that a minimum clearance of 1.2 m shall be provided where the standard shoulder width is less than 1.2 m.** For RRR projects widths are shown in Table 307.3.

On curbed highway sections, a minimum clearance of 1 m should be provided along the curb returns of intersections and near the edges of driveways to allow for design vehicle off tracking (see Topic 404). Where sidewalks are located immediately adjacent to curbs, fixed objects should be located beyond the back of sidewalk to provide an unobstructed area for pedestrians.

In areas without curbs, safety shaped barrier face should be constructed integrally at the base of any retaining, pier, or abutment wall which faces traffic and is less than 4.6 m from the edge of traveled way (right or left of traffic and measured from the face of wall). See Index 1102.2 for the treatment of noise barriers.

The minimum width of roadway openings between temporary K-rail on bridge deck widening projects should be obtained from the District Permit Engineer. The Regional Permit Manager should be consulted on the use of the route by overwidth loads.

See Chapter 7 of the Traffic Manual for other requirements pertaining to clear

recovery zone, guardrail at fixed objects and embankments, and crash cushions.

309.2 Vertical Clearances

(1) *Major Structures.*

- (a) Freeways and Expressways, New Construction -- **5.1 m shall be the minimum over all portions of the State facility (e.g., main lanes, shoulders, ramps, collector-distributor roads, speed change lanes, etc.).**
- (b) Freeways and Expressways, Overlay Projects -- **4.9 m shall be the minimum over all portions of the State facility.**
- (c) Conventional Highways and Local Facilities, All Projects -- **4.6 m shall be the minimum over the traveled way and 4.5 m shall be the minimum over the shoulders of all portions of the facility.**

(2) *Minor Structures.* **Pedestrian over-crossings shall have a minimum vertical clearance 0.5 m greater than the standard for major structures for the State facility in question.**

Sign structures shall have a vertical clearance of 5.5 m.

- (3) *42 000 km Priority Network.* This subset of the Interstate System is similar to what has previously been referred to as the National System of Interstate and Defense Highways. Those routes described in Table 309.2 and Figure 309.2 are given special attention in regards to minimum vertical clearance as a result of agreements between the FHWA and the Department of Defense. **Vertical clearance for structures on this system shall meet the standards listed above for freeways and expressways.** In addition to the standards listed above, vertical clearances of less than 4.9 m over any portion of this system will be subjected to extensive review by FHWA and must be approved by the Military Traffic Management Command in Washington D. C. Documentation similar to, but less extensive than a Design Exception Fact Sheet must be submitted to

FHWA to obtain approval for less than 4.9 m of vertical clearance. See W. P. Smith's memo dated August 20, 1993 to District Directors for more information on the Priority Network.

- (4) *General Information.* The standards listed above are the minimum allowable on the State Highway system for the facility and project type listed. For the purposes of these vertical clearance standards, all projects on the freeway and expressway system other than overlay projects shall be considered to be covered by the "new construction" standard.

When approved by a design exception (see HDM Index 82.2) clearances less than the values given above may be allowed on a case by case basis given adequate justification based upon engineering judgment, economic, environmental or right of way considerations. Typical instances where lesser values may be approved are where the structure is protected by existing lower structures on either side or where a project includes an existing structure that would not be feasible to modify to the current standard. In no case should vertical clearance be reduced below 4.6 m over the traveled way or 4.5 m over the shoulders over any portion of a State highway facility.

Efforts should be made to avoid decreasing the existing vertical clearance whenever possible and consideration should be given to the feasibility of increasing vertical clearance on projects involving structural section removal and replacement. Any project that would reduce vertical clearances below 5.1 m or lead to an increase in the vertical clearance should be brought to the attention of the Project Development Coordinator, the District Permit Engineer and the Regional Permit Manager at the earliest possible date.

The Regional Permit Manager should be informed of any changes (temporary or permanent) in vertical clearance.

- (5) *Federal Aid Participation.* Federal-aid participation is normally limited to the following maximum vertical clearances unless there are external controls such as the need to provide for falsework clearance or

Table 309.2
CALIFORNIA ROUTES
ON THE 42 000 km
PRIORITY NETWORK

ROUTE	FROM	TO
I-5	U. S. Border	I-805 just N. of U. S. Border
I-5	I-805 N. of San Diego	I-405 near El Toro
I-5	I-210 N. of Los Angeles	Redding
I-8	Junction at I-5 near San Diego	Arizona
I-10	Junction at I-5 near Los Angeles	Arizona
I-15	Junction at I-10 near San Bernardino	Nevada
I-40	Junction at I-15 near Barstow	Arizona
I-80	Junction at I-5 in Sacramento	Nevada
I-210	I-5 N. of Los Angeles	I-605
I-280	Junction at I-680 in San Jose	At or near south city limits of San Francisco to provide access to Hunter's Point
I-405	I-5 near El Toro	Palo Verde Avenue just N. of I-605
I-580	Junction at I-680	Junction at I-5
I-605	I-405 near Seal Beach	I-210
I-680	Junction at I-280 in San Jose	Junction at I-780 near Benicia
I-780	Junction at I-680 near Benicia	Junction at I-80 in Vallejo
I-805	I-5 just N. of U. S. Border	I-5 N. of San Diego

the vertical clearance is controlled by an adjacent structure in a multi-structure interchange:

a) Highway Facilities.

- 5.3 m over freeways and expressways.
- 4.8 m over other highways (4.7 m over shoulders).
- For pedestrian structures, 0.7 m greater than the above values.

(b) Railroad Facilities.

- 7.1 m over the top of rails for non-electrified rail systems.
- 7.4 m over the top of rails for existing or proposed 25 kv electrification.
- 8.0 m over the top of rails for existing or proposed 50 kv electrification.

These clearances include an allowance for future ballasting of the rail facility. The cost of reconstructing or modifying any existing railroad-highway grade separation structure solely to accommodate electrification will not be eligible for Federal-aid highway fund participation. Where a rail system is not currently electrified, the railroad must have a plan adopted which specifies the intent to electrify the subject rail segment within a reasonable time frame in order to provide clearances in excess of 7.1 m.

Any exceptions to the clearances listed above should be reviewed with the FHWA early in the design phase to ensure that they will participate in the structure costs. All excess clearances should be documented in the project files as to reasons and appropriate concurrences.

309.3 Tunnel Clearances

- (1) *Horizontal Clearances.* Tunnel construction is so infrequent and costly that the width should be considered on an individual basis.

The minimum width of freeway tunnels should equal the full width of traveled way and paved shoulders on the roadway approaches as set forth in Index 208.1, Bridge Width.

Normally, the minimum horizontal clearance on freeways should include the full roadbed width of the approaches.

In one-way tunnels on conventional highways the minimum side clearance from the edge of the traveled way shall be 1.5 m on the left and 2.0 m on the right. For two-way tunnels, this clearance shall be 2.0 m on each side.

- (2) *Vertical Clearances.* **The minimum vertical clearance shall be 4.6 m measured at any point over the traveled way and 4.5 m above the gutter at the curb line. On freeways and expressways, the vertical clearance listed in Index 309.2(1)(a) shall be used.** Cost weighed against the probability of over-height vehicles will be the determining factors.

309.4 Lateral Clearance for Elevated Structures

The minimum horizontal clearance between elevated highway structures, such as freeway viaducts and ramps, and adjoining buildings or other structures, shall be 4.6 m for single-deck structures and 6.1 m for double-deck structures. Spot encroachments on this clearance shall be approved in accordance with Index 82.2.

309.5 Structures Across or Adjacent to Railroads

Regulations governing clearances on railroads and street railroads with reference to side and overhead structures, parallel tracks, crossings of public roads, highways, and streets are established by the PUC.

- (1) *Normal Horizontal and Vertical Clearances.* Although General Order No. 26-D specifies a minimum vertical clearance of 6.86 m

above tracks on which freight cars not exceeding a height of 4.72 m are transported, a minimum of 7.01 m should be used in design to allow for reballasting and normal maintenance of track. Railroads on which freight cars are not operated, should have a minimum vertical clearance of 5.79 m. In establishing the grade line, the District should consult the DOS to obtain the depth of structures and false work requirements, if any (see Index 204.6(4)).

At underpasses, General Order No. 26-D establishes a minimum vertical clearance of 4.27 m above any public road, highway or street. **However, the greater clearances specified under Index 309.2 shall be used.**

All curbs, including median curbs, should be designed with 3.05 m of clearance from the track centerline measured normal thereto.

The principal clearances which affect the design of highway structures and curbs are summarized in Tables 309.5A and B. It should be noted that collision walls may be required for the clearances given in Columns (3) and (4) of Table 309.5B. Usually, no collision walls are required if the clearance 3.05 m or more on tangent track and 3.35 m or more on curved track.

Table 309.5A

**Minimum Vertical Clearances
Above Highest Rail**

Type of Structure	Type of Operation	
	Normal Freight	No Freight Cars Operated
Highway overhead and other structures including through railroad bridges.	7.01 m	5.79 m

(2) *Off-track Maintenance Clearance.* The 5.49 m horizontal clearance is intended for sections of railroad where the railroad company is using or definitely plans to use off-track maintenance equipment. This clearance is provided on one side of the railroad right of way.

On Federal-aid projects, where site conditions are such that off-track maintenance clearance at an overpass is obtained at additional cost, Federal-aid funds may participate in the costs of such overhead designs that provide up to 5.49 m horizontal clearance on one side of the track. In such cases, the railroad is required to present a statement that off-track maintenance equipment is being used, or is definitely planned to be used, along that section of the railroad right of way crossed by the overhead structure.

(3) *Walkway Clearances Adjacent to Railroads.* All plans involving construction adjacent to railroads should be such that there is no encroachment on the walkway adjoining the track. Walkway requirements are set forth in General Order No. 118 of the PUC. Where excavations encroach into walkway areas, the contractor is required to construct a temporary walkway with handrail as set forth in the contract special provisions.

(4) *Approval.* All plans involving clearances from a railroad track must be submitted to the railroad for approval as to railroad interests. Such clearances are also subject to approval by the PUC.

To avoid delays, early consideration must be given to railroad problems when design is started on a project.

Topic 310 - Frontage Roads

310.1 Cross Section

Frontage roads are normally relinquished to local agencies. Index 308.1 gives width criteria for city streets and county roads. These widths are also applicable to frontage roads.

Table 309.5B

Minimum Horizontal Clearances to Centerline of Nearest Track

Type of Structure	Off-track Maintenance Clearance	Tangent Track Clearance	Normal Curved Track ⁽¹⁾ Clearance	Curved Track Clearances When Space is Limited ⁽¹⁾	
				Curves of 0° to 12°	Curves of 12° or more
Through rail-road bridge	None	2.44 m ⁽²⁾⁽⁴⁾	2.74 m ⁽²⁾⁽⁴⁾		
Highway over-head and other structures	5.49 m clear to face of pier or abutment on side railroad requires for equipment road.	2.59 m ⁽⁴⁾	2.90 m ⁽⁴⁾	2.59 m (Min.) ⁽³⁾	2.59 m + 0.013 m ⁽³⁾ per degree of curve.
Curbs		3.05 m			

(1) The minimum, in general, is 0.30 m greater than for tangent track.

(2) With approval of P.U.C.

(3) Greater clearance necessary if walkway is required.

(4) Collision walls may be required. See Index 309.5(1).

However, the minimum paved cross section for urban frontage roads shall be two 3.6 m lanes with 1.2 m outside shoulders. (See Chapter 1000 for shoulder requirements when bicycles are present.) **The minimum paved cross section for rural frontage roads shall be 7.2 m.**

310.2 Outer Separation

In urban areas and in mountainous terrain, the width of the outer separation should be a minimum of 8 m from edge of traveled way to edge of traveled way. A greater width may be used where it is obtainable at reasonable additional cost, for example, on an urban highway centered on a city block and paralleling the street grid.

In rural areas, other than mountainous terrain, the outer separation should be a minimum of 12 m wide from edge of traveled way to edge of traveled way.

See Figure 307.4 for cross sections of outer separation and frontage road.

310.3 Headlight Glare

Care should be taken in design of new frontage roads to avoid the potential for headlight glare interfering with the vision of motorists traveling in opposite directions on the frontage roads and in the outer freeway lanes. The preferred measures to prevent headlight glare interference on new construction are wider outer separations, revised alignment and raised or lowered profiles.